Chapter 3
Selection of Closure Types

3-1. Facilities Requiring Closures

Closure structures are required at openings in levee and floodwall systems when facilities such as railroads, roadways, and pedestrian walkways pass through levee and floodwall systems at elevations below the level of protection provided by the project. The widths of openings for these facilities vary depending upon their functional purpose. Openings for railroads and roadways vary from moderate widths (20 to 40 ft) to widths of 100 ft or more. Openings for pedestrian walkways are usually 20 ft or less. The need for closures should be avoided when possible by using ramps or pedestrian overpasses.

3-2. Closure Structure Types

Closure structures for openings in levee and floodwall systems of LFPPs are usually either stoplog or gate type closures. Stoplog closure structures are usually the least expensive. Gate closure structures are more functional because they can usually be closed and opened quickly and with less effort.

a. Stoplog closure structures. Stoplog closure structures usually consist of one or more sets of horizontal aluminum or steel beams, stacked vertically in the closed position. Aluminum stoplogs weigh less than steel stoplogs of the same size but do not have the same strength. For narrow openings, one set of beams or logs may span between support slots constructed at the edge of openings. For wider openings, intermediate, removable support posts are required as shown in Figure 3-1. Seals are not normally attached to the stoplogs; however, plastic sheeting, sandbags, or other available means should be used to reduce leakage through the stoplog closure structure. Storage facilities must be provided for the stoplogs, removable posts, and accessories. When secured areas are available, closure items may be stored on uncovered storage concrete pedestals or slabs; otherwise, a storage building must be provided. Typical details of a stoplog closure structure are shown in Plates 1-2. Advantages and disadvantages of stoplog closure structures are given below.

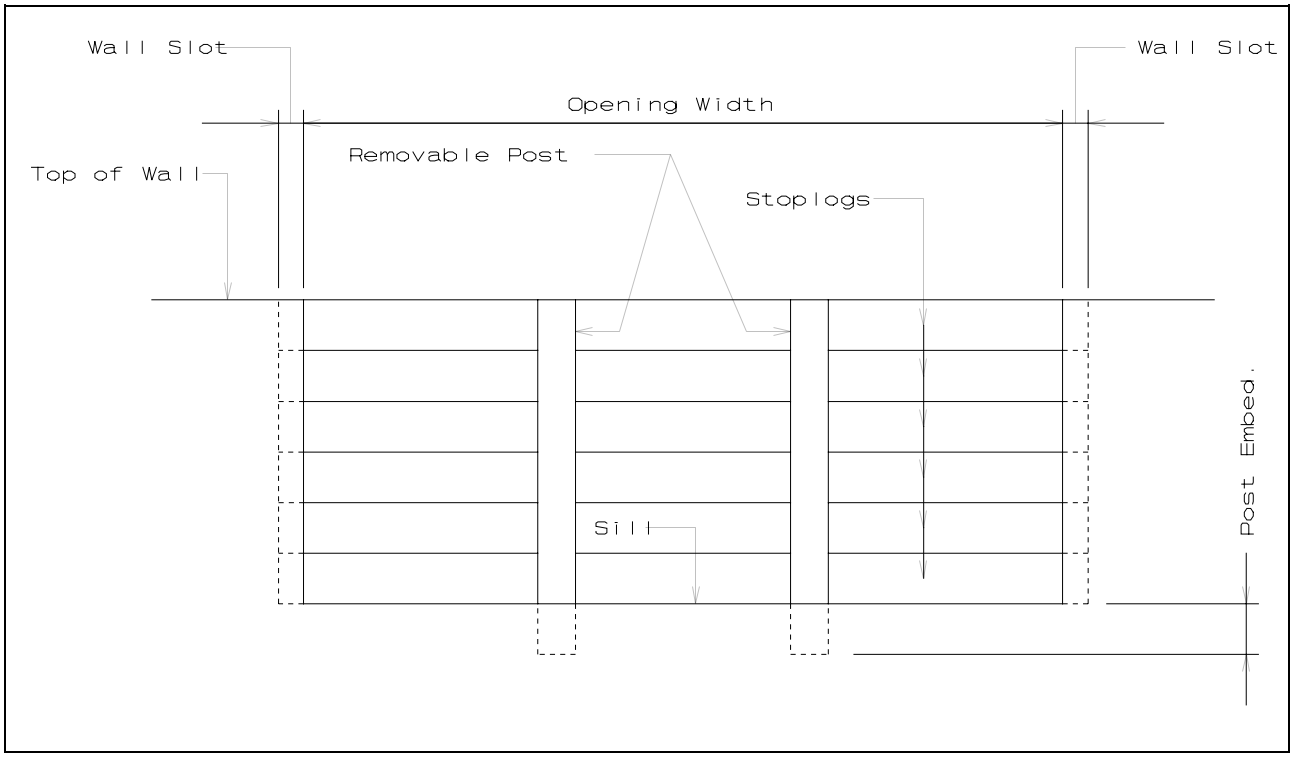


Figure 3-1. Stoplog closure structure

Advantages:

- Fabrication methods are simple and economical.

- Initial cost is usually less than for gate closures.

- Is easily operated for narrow and low openings.

Disadvantages:

- Intermediate support posts or wide stoplogs are required for wide openings which usually require special lifting equipment for installation.

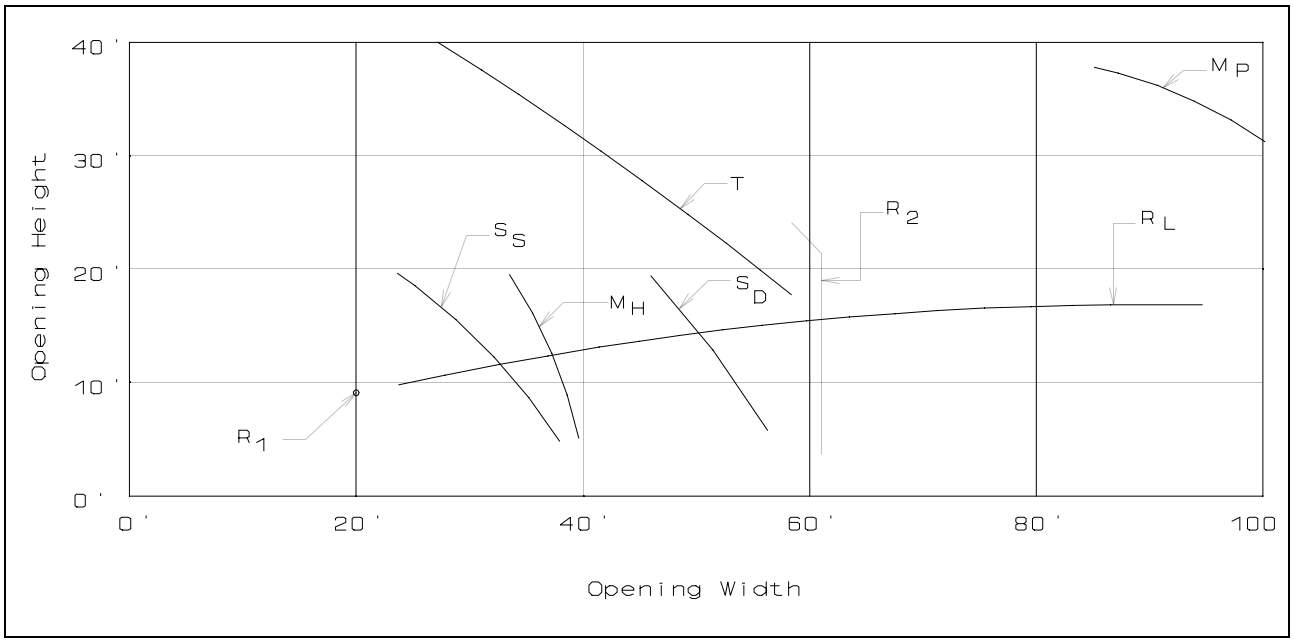
- Accurate long-range weather forecasting is needed since a relatively long lead time is required to mobilize personnel and equipment for installation.

- Installation time is usually increased to allow cleaning of the post sockets during installation.

- Installation time is longer than required to close gated closures.

- A storage building is required to prevent damage by vandalism or loss by theft.

b. Gate closure structures. The most common type of gates used for gate closure structures are swing, miter, rolling, and trolley gates. Figure 3-2 shows outside boundary envelopes for a limited number of gate closure structures from past Corps projects. Gate types are plotted relative to the size of the closure opening. The gate sizes enclosed by the envelopes lie to the left and below the applicable curve or line. Figure 3-2 shows the type of



LEGEND

S_S = Swing gate, single leaf.
S_D = Swing gate, double leaf.
M_H = Miter gate with hinges.
M_P = Miter gate with pintle, continuous quoin, and miter posts.
R_2 = Rolling gate stabilized by a double line of wheels.
R_1 = Rolling gate with a single line of wheels, trolley stabilized.
R_L = Rolling gate - L-frame, latch stabilized.
T = Trolley gate.

Figure 3-2. Gate type versus opening dimensions

gate and height-to-width relationships used in past designs and is not intended to establish the maximum opening sizes for any particular gate type used in future designs.

(1) Swing gates. Swing gates are composed of two or more horizontal girders, vertical intercostals, vertical end diaphragms, a skin plate, and diagonal braces. Swing gates are supported on one side by top and bottom hinges attached to a support structure as shown in Figure 3-3. In most cases, swing gate closures consist of a single swing gate leaf. However, double leaf gates are used for wide openings. Double leaf gates must be stabilized by a removable center post or diagonal tie-back linkages as shown in Figure 3-4. One end of the diagonal linkage rods shall be permanently attached to the free ends of each gate leaf. The other end of the each linkage rod is attached to the support structure when the gates are closed. A support jack is provided beneath the gate to withstand the vertical component of load from the linkage rods. Rubber J-seals are attached to gates to form a continuous water-tight seal between the gates and supporting walls and sill of the opening. Closure provisions should include the use of winches or motor vehicles to accomplish closure during strong winds. Typical details of a swing gate closure structure are shown in Plate 3. Typical details of hinges, seals and latches are shown in Plates 4-12. Advantages and disadvantages of swing gate closure structures are given below.

Advantages:

- Single leaf swing gates are more practical for opening widths up to 40 ft.

- Skilled personnel or equipment are not required for operation except when removable intermediate support posts are used with double leaf gates.

- A short lead time is required for making closure except when removable intermediate support posts are used with double leaf gates.

Disadvantages:

- Requires right-of-way area for operating.

- Requires complex shop fabrication with machine work.

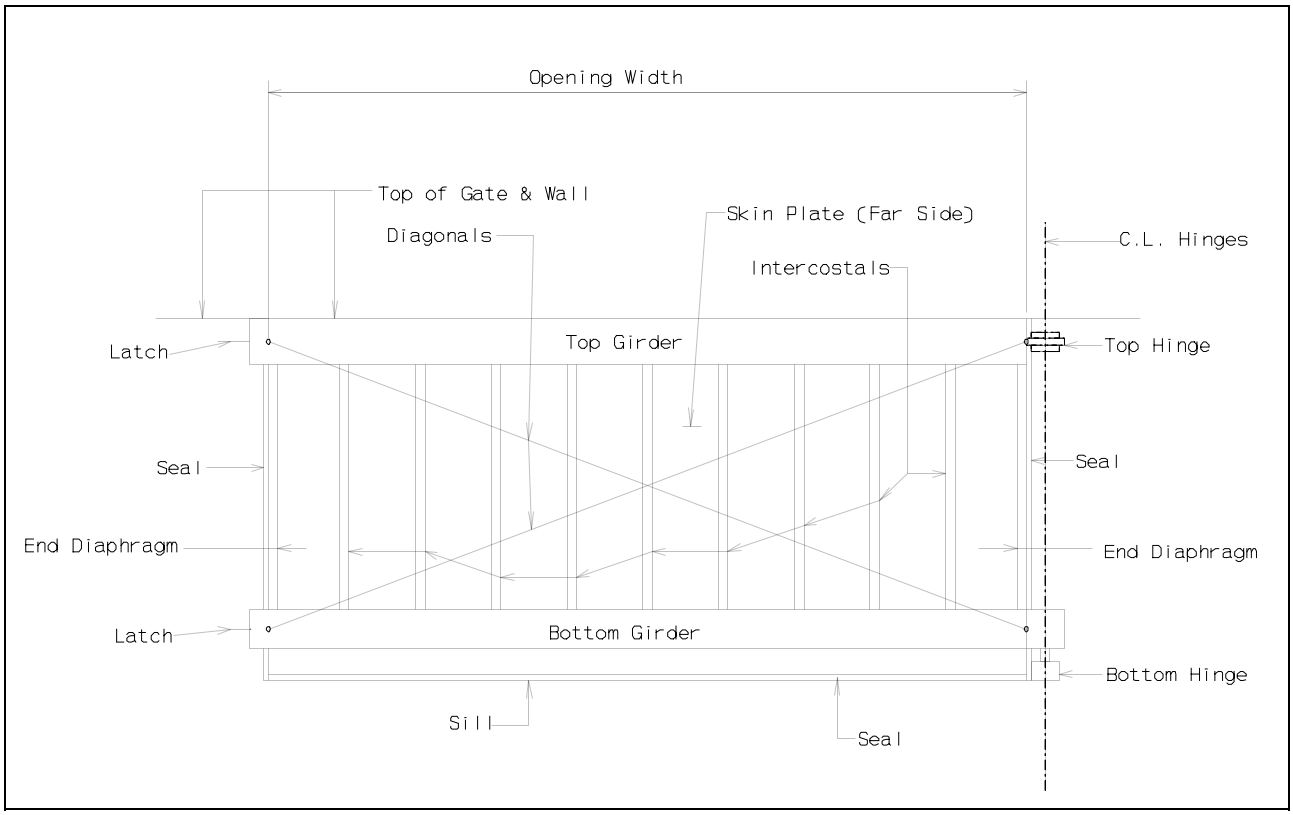


Figure 3-3. Swing gate closure structure

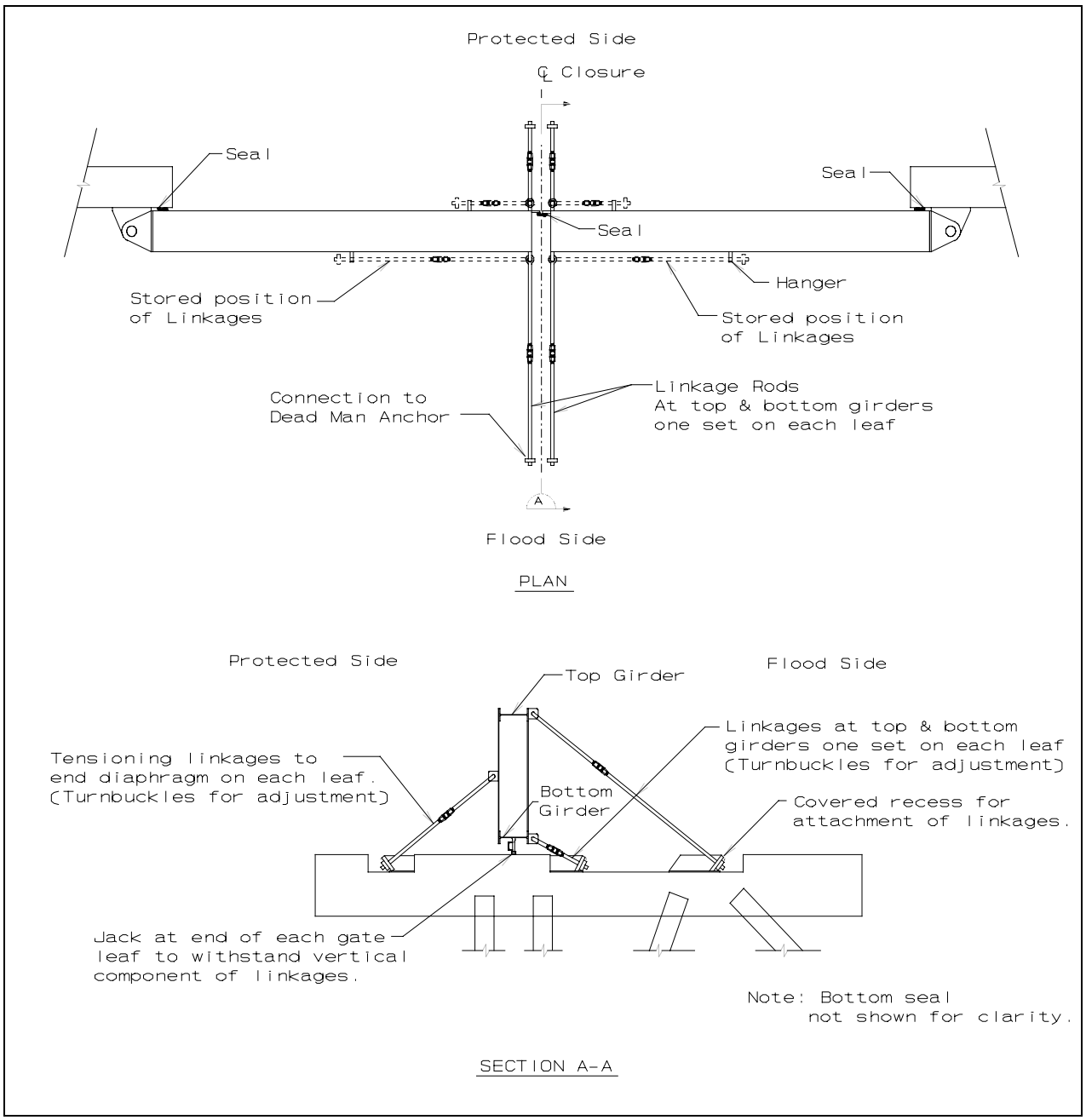


Figure 3-4. Tie-back linkage for double leaf swing gate

- A storage facility is required when removable intermediate support posts are used with double leaf gates.

- Requires a retractable bottom sill to accommodate nonlevel sill surfaces.

- Is difficult to operate during high winds.

(2) Miter gates. Miter gates consist of two leaves that form a three-hinged arch when the gates are in the closed position. Each gate leaf is composed of: horizontal girders, vertical intercostals, vertical end diaphragms, a skin plate, and adjustable diagonal tension rods. The gate leaves are attached to support piers by top and bottom hinges as shown in Figure 3-5. The diagonal tensioning

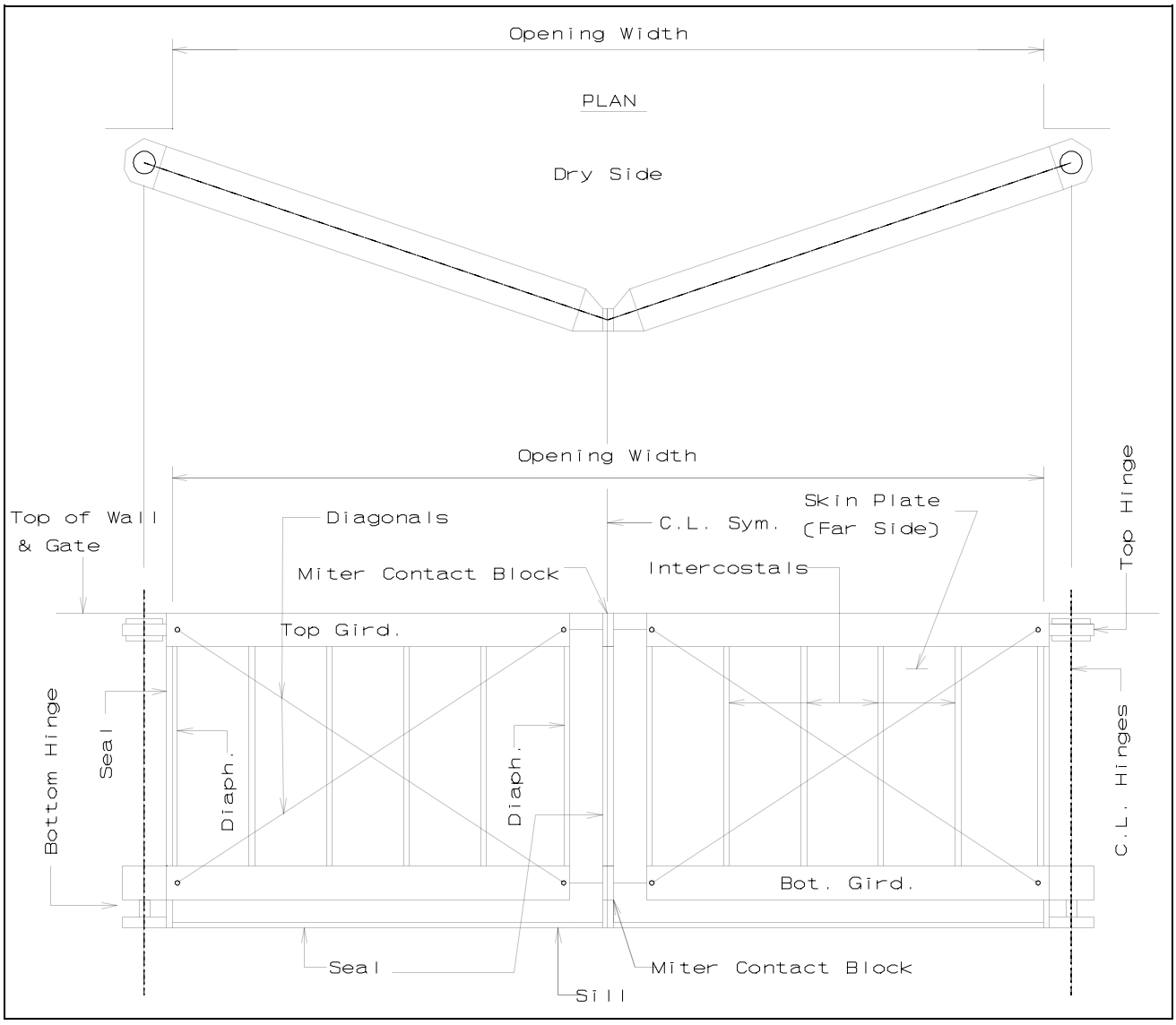


Figure 3-5. Miter gate closure structure

rods are required to prevent twisting of the gate leaves due to their dead load and must be properly tensioned after the gates are installed so that the gates hang plumb and miter properly. Typical diagonal prestressing notes are given in Plate 13. For miter gates with two horizontal girders, the three-hinged arch reactions are resisted by the top and bottom hinges at the supports and spot bearing blocks at the miter ends of the horizontal girders. The magnitude of loading on large miter gates requires the use of three or more horizontal girders, quoin posts with bearings attached to the support piers, and continuous miter posts at the miter ends of the gates to accommodate the forces. Also, hemispherical pintles and top linkages, similar to navigation lock gates, may be required instead of hinges. Provisions for the design of hemispherical pintles and top linkages are given in EM 1110-2-2703. Hinges and miter blocks or bearing posts must be adjustable to accommodate construction tolerances and allow the gates to miter properly. Support structures for miter gates are usually more difficult to design and cost more than support structures for other types of gates. The supporting structures and their foundations must be designed to minimize the deflections at the gate hinges or quoin posts so that the gates will function as designed. J-seal assemblies are provided for water tightness. Latches are provided to secure the gates in the stored and closed position. Seal, hinge, and latch details for miter gates are similar to those used for swing gates. Closure

provisions should include the use of winches or motor vehicles to accomplish closure during strong winds. Typical details of a miter gate closure structure are shown in Plates 14-16. Advantages and disadvantages of miter gate closure structures are given below.

Advantages:

- Is suitable for large openings.

- Closure can be made quickly without the use of skilled personnel.

- A storage building is not required.

- Weighs less than other types of gates designed for large openings.

- A center support is not required.

Disadvantages:

- Requires complex shop fabrication with machine work.

- Requires right-of-way area for operating.

- Support structure is more complex to design and more expensive than for other gate types.

- Requires a retractable bottom seal to accommodate nonlevel sill surfaces.

- Is difficult to operate during high winds.

(3) Rolling gates. Rolling gates are composed of a structural steel frame covered with a water barrier skin plate. The gates are supported by wheels that roll on tracks embedded in the sill across the closure opening and the storage area. J-seals are attached to the ends and bottoms of the gates to form a water-tight seal between the gates and the plates embedded in the end supports and the bottom sill. The gates are sometimes operated by a cable attached to a truck motorized winch; however, the cable could also be connected directly to a truck which pulls the gate open or closed. Alternately, the design may consist of a winch mounted at the site for gate operations. Gates along fast rising streams may be designed to be opened or closed from the protected side of the floodwall as shown in Plates 17-20. Latches should be provided to secure the gates in the stored and closed positions.

(4) Rolling gate - stabilized with two lines of wheels. Rolling gates stabilized with two lines of wheels are composed of: horizontal girders, vertical intercostals, vertical end and intermediate plate diaphragms, a skin plate, and two lines of support wheels as shown in Figure 3-6. The wheels support and stabilize the gate against overturning. The wheels are usually V-grooved castings and roll on tracks that are usually inverted angles with embedded anchorages. The depth of the bottom girder is usually governed by the required transverse spacing between the supporting wheels rather than the hydrostatic load. A girder depth of 30 to 36 in. is normally required to accommodate the spacing between the two lines of wheels to provide stability of the gate during opening and closing operations. Typical details of a rolling gate stabilized with two lines of wheels are shown in Plate 21. Advantages and disadvantages of rolling gates stabilized with two lines of wheels are given below.

Advantages:

- Is adaptable to wide openings.

- Closure can be made quickly without the use of skilled personnel.

- A storage building is not required.

- Requires small storage space.

Disadvantages:

- Requires a retractable bottom seal to accommodate nonlevel sill surfaces.

- Unless wheel assemblies are designed to accommodate the lateral bottom girder deflection, jacks must be provided to lift the wheel assemblies from the tracks when the gate is in the closed position.

- Requires level storage area immediately adjacent to the closure opening.

(5) Rolling gate - with single line of wheels and stabilizing trolleys. These gates are usually composed of a trussed steel frame covered with skin plate or bridge planks. The gates are supported at the bottom by a single line of wheels and are stabilized laterally by an extended top girder supported by trolleys attached to the top of the floodwall as shown in Figure 3-7. Girder depths are usually governed by the hydrostatic loading on the gate.

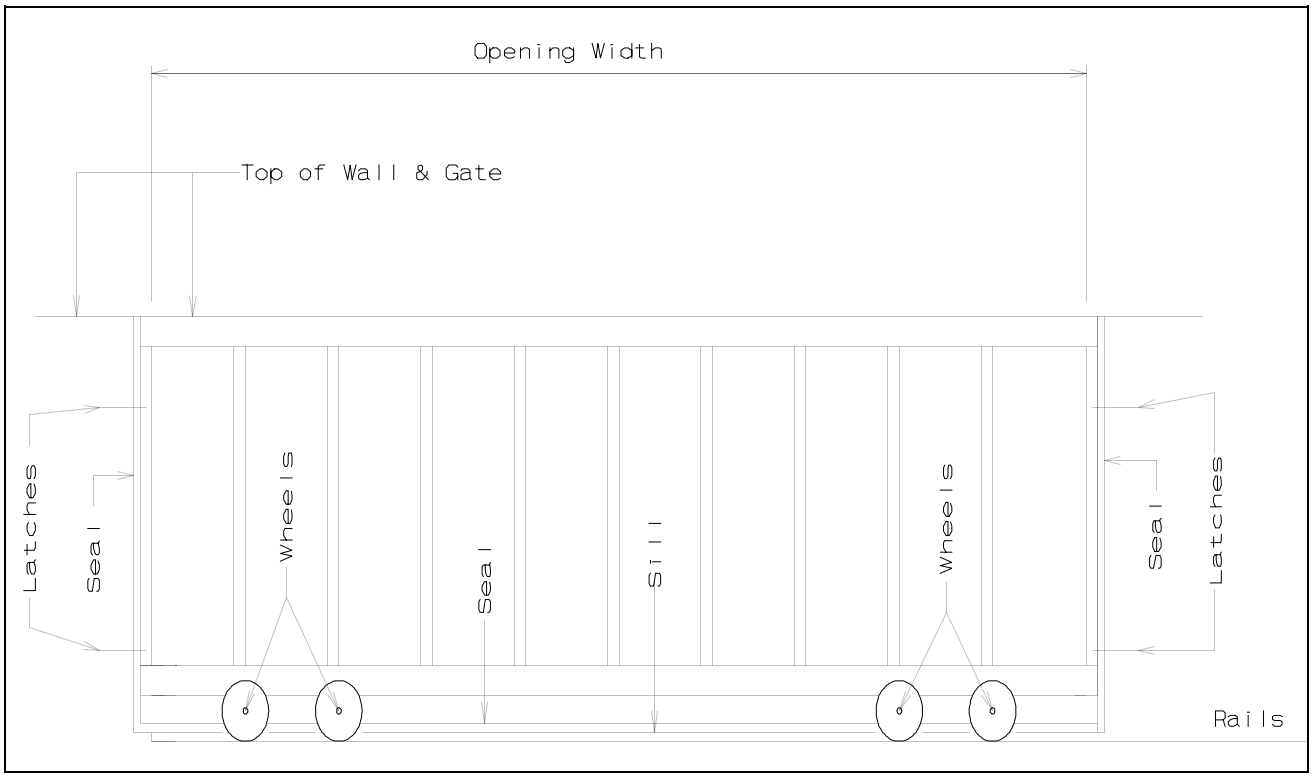


Figure 3-6. Rolling gate - stabilized with two lines of wheels

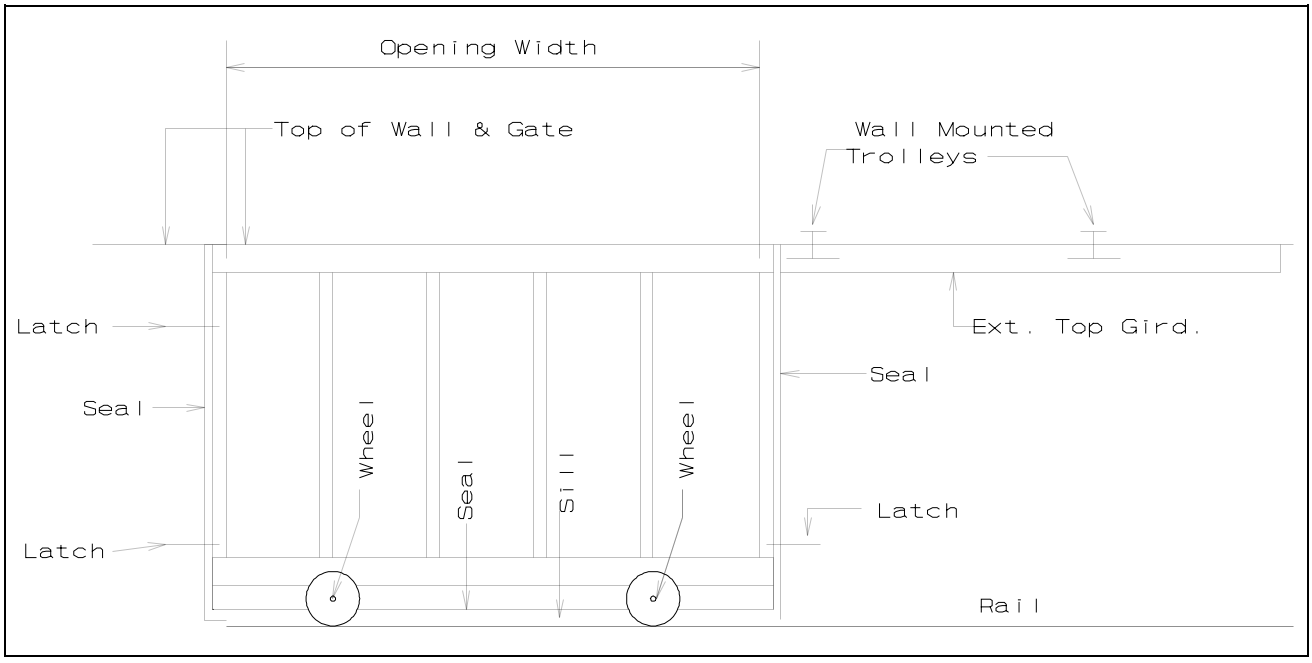


Figure 3-7. Rolling gate - single line of wheels and stabilizing trolleys

Typical details of a rolling gate with a single line of wheels and stabilizing trolleys are shown in Plate 22. Advantages and disadvantages of rolling gates with a single line of wheels and stabilizing trolleys are given below.

Advantages:

- Is practical for closure widths up to 30 ft.

- Closure can be made quickly without the use of skilled personnel.

- A storage building is not required.

- Requires small storage space.

Disadvantages:

- Requires a retractable bottom seal to accommodate nonlevel sill surfaces.

- Requires level storage area immediately adjacent to the closure opening.

(6) Rolling gate - L-frame. These gates are usually composed of a series of L-shaped structural steel frames interconnected by horizontal and diagonal members. The gates are supported at the bottom by two lines of wheels as shown in Figure 3-8. Hooks attached to the heel of each of the L-frames engage anchorages embedded in the concrete sill structure to stabilize the gate against hydrostatic loadings. Typical details of an L-frame rolling gate are shown in Plate 23. Advantages and disadvantages of L-frame rolling gates are given below.

Advantages:

- Can be designed for any opening width.

- Can be shop-fabricated in sections to simplify handling and storage.

- Closure can be made quickly without the use of skilled personnel.

- A storage building is not required.

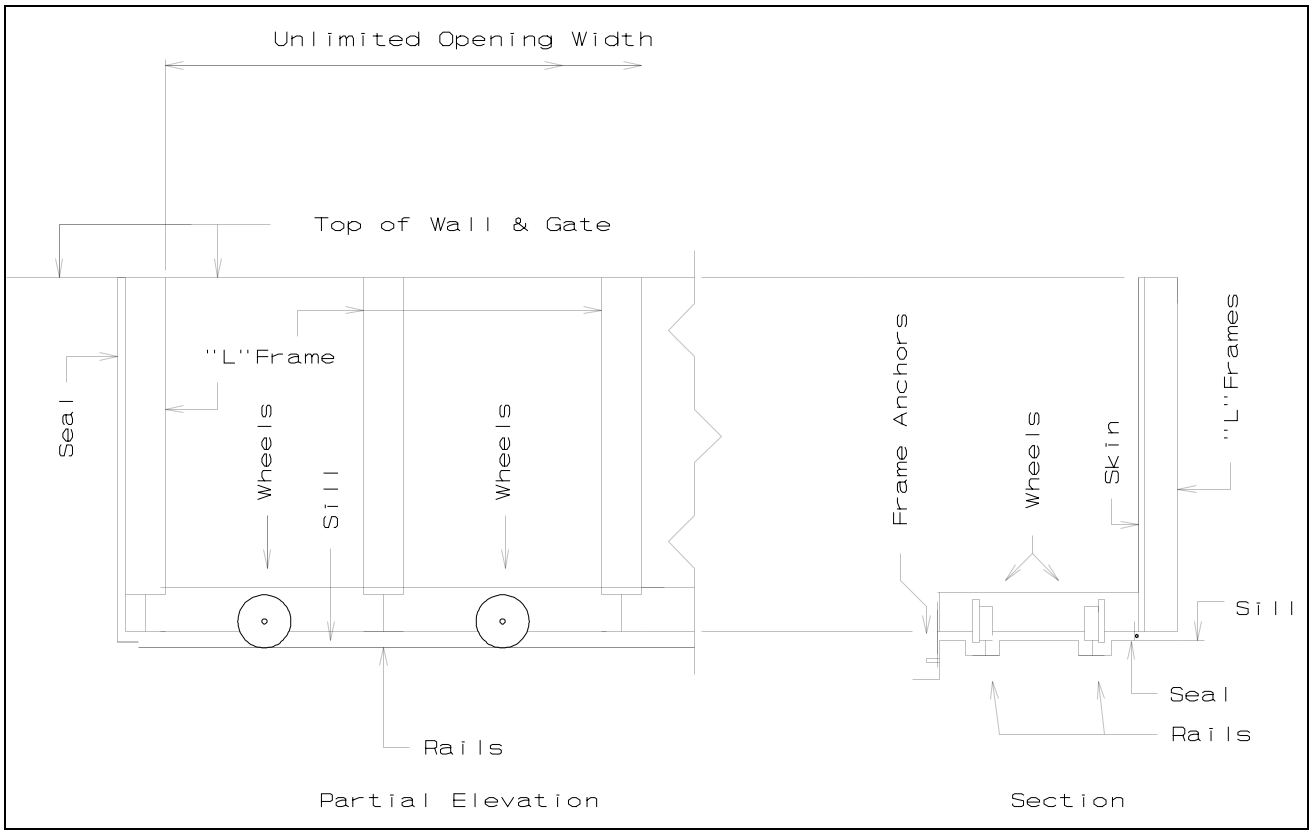


Figure 3-8. Rolling gate - L-frame stabilized by hooks

- Requires small storage space.

Disadvantages:

- Requires a retractable bottom seal to accommodate nonlevel sill surfaces.

- Requires level track surface.

- Requires level storage area immediately adjacent to the closure opening.

- Requires wide sill to accommodate the installation of tracks and hook anchorages.

(7) Trolley Gates. Trolley gates are usually composed of top and bottom horizontal girders, other secondary framing members, and a skin plate. Trolley gates are suspended from trolleys running on an overhead rail and beam supported by the floodwall as shown in Figure 3-9. The gates are opened and closed by a winch arrangement similar to that used for rolling gates. Typical details of a trolley gate closure structure are shown in Plate 24. Advantages and disadvantages of a trolley gate closure structure are given below.

Advantages:

- Is practical for closure widths up to 60 ft.

- Closure can be made quickly without the use of skilled personnel.

- Can obtain a good seal against irregular sill surfaces.

- A storage building is not required.

- Requires small storage space.

- Is suitable for railroad closures because required vertical clearances for railroads are fixed.

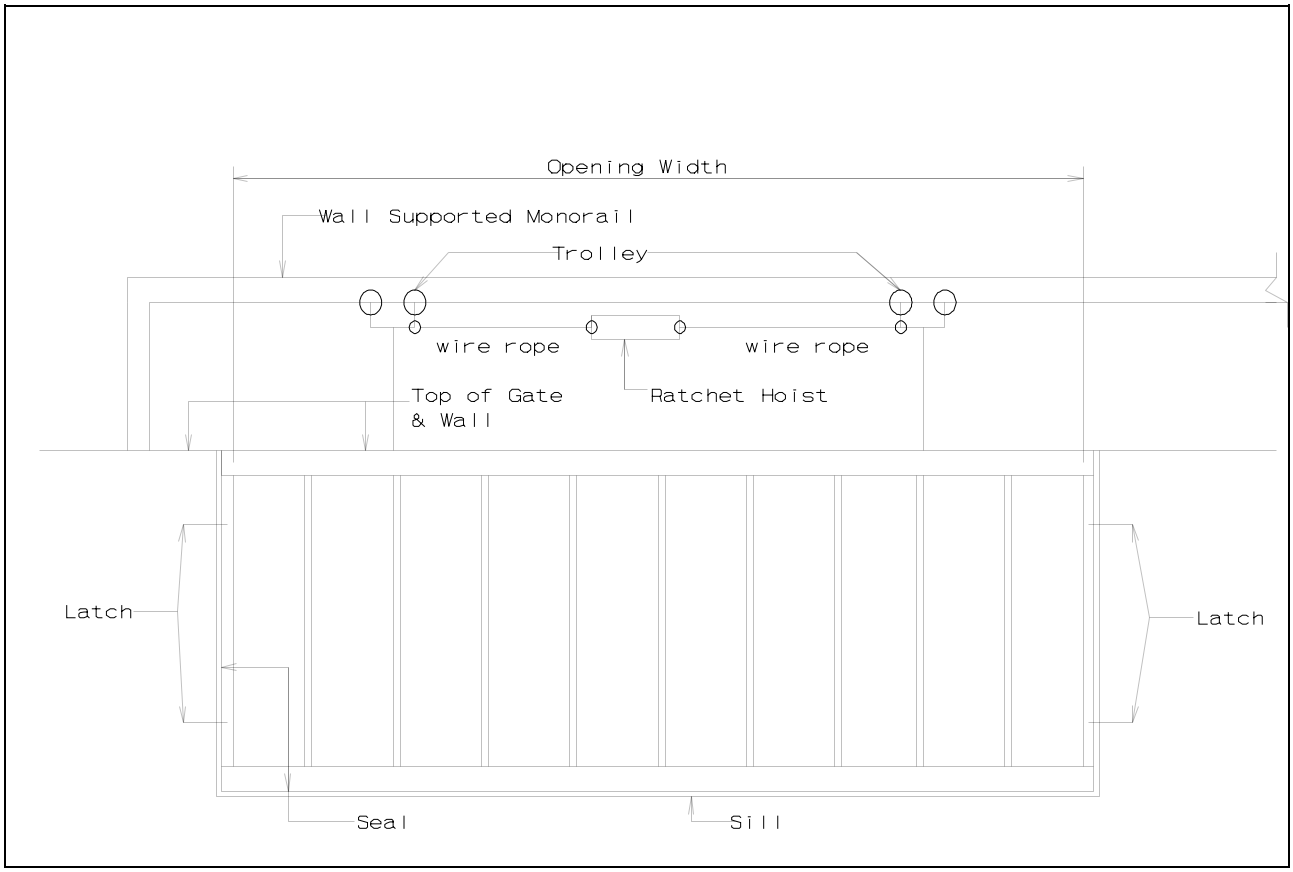


Figure 3-9. Trolley gate

Disadvantages:

- Slope of the ground adjacent to the closure opening must allow adequate clearance to open the gate.

- May be rendered inoperative due to permanent overhead support members being damaged by vehicles or other sources, or removable overhead support members or their anchorages being damaged during removal or placement operations.

- A guide member at the base of the gate may be required to support the gate against wind loads during opening and closing operations.

c. Prefabricated stoplogs and gates. Prefabricated stoplogs and gates are commercially available and are usually more cost effective for closure structures with small openings.